PATENT APPLICATION OF

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for

DEVICE FOR LOCATING AND RETRIEVING SMALL ARTICLES

Background: Field of Invention

This invention relates to a method and apparatus for locating and retrieving one or more small, "hard to see articles" which have been lost or misplaced within a certain area, and in particular to a method and apparatus that utilizes a standard vacuum cleaning system as the motive force for that task.

Prior Art

Heretofore, devices for finding and retrieving small articles have included the deployment of magnetic attraction, which limits the expectation of successful recovery only to items containing ferrous materials.

There also exist vacuum operated retrieval devices capable of filtering the air stream and thus preventing non-ferrous articles from passing through (2,293,920 and 2,354,089 Repogle; 2,467,652 Beede; 4,833,753 Muller; 5,375,293 Gilbertson). However, because they are intended for a general sampling or sifting of the air stream, with the goal of simply intercepting whatever may turn up, rather than to search for a specific article or articles, known by the user to be of certain size, and within an area of known limits, such devices are not capable of performing completely thorough, reliable and satisfactory searches due to having a number of deficiencies. Noteworthy among these are:

- Disassembly and manual cleaning is required to purge debris from filter elements (Repogle, Beede, Gilbertson).

- Secondary filters, when installed, do not cancel out the effect of the primary filter, but act in concert with it, thus debris build-up continues unabated. To change to another filter size, tedious and time-consuming disassembly is required. (Muller)

- The absence of positive means for holding trapped articles securely within the device, unless the suction tube is maintained in a horizontal or near horizontal position, whereas a near vertical position is much more natural when employing a vacuum wand for most cleaning applications.

- The necessity to partially disassemble the device in order to eject the trapped articles.

Background: Basic Problems To be Solved

For the purpose of this description, and to fully comprehend and appreciate the merits of this invention, the term "small article" or simply "article", is defined as encompassing a variety of unrelated solid and semi-solid objects, any of which fall in a size range where the smallest is on the threshold of being visibly discerned by those with the best eyesight, and where the largest is limited in size and weight only to the size of the inlet aperture of the device and to the available suction force of the vacuum system utilized. To further define "article", it can consist of any known material or combination of materials, natural or manmade, and be of any shape and density whatsoever. Furthermore, it can be of any color or absence of color, and of any surface condition, such as smooth, rough, textured, hard or soft, hot or cold.

The need for timely recovery of such an article is proportionate not only to its intrinsic value, but often more so to its inherent importance and to the fact that it may be irreplaceable due to its own unique purpose or function, or to the urgency of the users reliance upon it at the time of its disappearance.

These aspects are most readily understood when evaluating some typical examples:

Household, Business and General Situations:

Jewelry: earrings, gemstones, beads, pearls, etc. (Monetary, sentimental value)
Pendants, chain links, loops, hooks, buttons, (Needed to repair, restore jewelry)
Contact lenses (In the absence of which the user is partially incapacitated)
Prescription pills (Urgently needed, yet replenishments not readily obtainable)
Tooth or tooth fragments, natural or denture (Needed to repair)
Miniature hardware: screws, nuts, washers, (Needed to finish urgent tasks)
Broken fragments of damaged valuables (Needed to reconstruct)
Small valuables recovered from cars in a car wash

Commercial or Industrial Situations:

Special fasteners and components used in the assembly of products, such as
Screws, nuts, washers, rivets, pins, steel balls, O-rings, gaskets:
Electronic parts: microchips, resistors, diodes, condensers, IC's:
Miniature components, such as gears, springs, clamps and the like.

Losing Small Valuables

Often such a small article accidentally drops onto the floor or some kind of work surface, or somewhere inside of a car, or on a sofa, bed and other furniture, and in various other areas too numerous to foresee. If the floor is carpeted, and the article happens to be of certain prerequisite dimensions, unique shape and texture, it may sink below the surface of the nap, so as to completely disappear from sight. If the floor is hard (hardwood, tile, linoleum, concrete or the like), the article may bounce, roll or

slide a considerable distance from the drop point, and in a direction not always observed. It may come to rest behind or beneath an obstruction, lodge in a crevice, or simply blend in with the surface. Depending on the type, size, color and other outwardly observable characteristics of the article, as well as on the eyesight of the person(s) looking for it, any of the scenarios described here by way of example can make it extremely difficult and time consuming, if not impossible, to find and recover such an article by merely scanning the surrounding area visually.

Sometimes the absence of an article lost in this context is not necessarily discovered at the moment of its disappearance, but may become known only after a passage of time. In such a case, mental recollection and deduction may lead to defining an area suspected of containing the lost article, and the dimensional limits of that suspected area are usually much greater than they would have been, had the loss of the article been noticed at the time of its disappearance. Here a visual inspection alone would obviously take even more time and effort, while at the same time being less likely to yield a positive result.

The task of locating a dropped article is made even more difficult if it falls onto a surface already covered with a dense layer of particulate matter, such as dirt, sand, stone pebbles, sawdust, concrete mix, flour or any kind of granular or powdery substance. In such cases the fallen article may end up being buried somewhere below the surface of such particulate matter, making visual locating all but impossible. Unless the area to be searched is relatively small, and the lost article relatively large in proportion to the granular matter, manual sifting by hand or with the help of sieves or screens may prove to be unacceptably cumbersome and time consuming.

Primary Object

Accordingly, it is an object of this invention to provide a method and apparatus for quickly locating and retrieving any article of the kind described above, and lost under circumstances similar to those cited herein, without having to know its exact location, by searching the general area known to contain the lost article, until it is found. The

method consists of the well known procedure of vacuum cleaning, utilizing any standard vacuum cleaning system in widespread existence in households, commercial, industrial and institutional establishments. The apparatus consists of a retrieval device which is adaptable mounted between whatever intake nozzle the user wishes to employ and the vacuum cleaner unit itself, and is so configured as to prevent the sought article, once intercepted, from being sucked into the system's debris receptacle, be that a filter bag, a bag-less reservoir, or a large drum, such as those used in central cleaning systems.

Dealing With Debris

Isolating the captured article from other debris picked up prior to and during the recovery process, such as dust, lint, hair, etc. not only improves its chances of being discerned, but also precludes the user from having to search through masses of unsightly and unhygienic debris. Thus it is a further object of this invention to provide a "jar like see-through chamber" small enough to facilitate instant recognition of any unique object entering and oscillating within its confines, thus signaling that the sought article may have been found, and from which it may then be quickly and easily ejected. At the same time, this chamber is made large enough to permit the possible accumulation of debris, which may be collecting as an unwanted byproduct of the process. To assure that the searched for article is trapped within this chamber and thus prevented from passing on through to the main debris receptacle, a filter element is provided which, at a minimum, performs three essential functions:

A. Presents a net open area at least equal to, or greater than the area of the main inlet nozzle.
B. Presents a clear flow path to the stream of supply air, and to any particulates entrained in it which are smaller in size than the size of the smallest article ever anticipated to be captured.
C. Presents an obstacle to any article of the same size and greater than the size of the smallest article ever anticipated to be captured, as measured across its smallest profile.

Function A. assures that the volume of airflow through the system is sufficient to maintain vacuum pickup.

Function B. allows dust particles, fine powder and similar small debris to pass through without clogging the filter.

Function C. prevents any article of requisite size from passing through the system, whether or not such an article is "wanted" or "unwanted". In this context, "unwanted" articles would include any debris present in the search area that is larger than the orifice size of the filter element, and which of necessity is also collecting in the "see-through chamber" of the device. See the later paragraph titled "Controlling Unwanted Debris" for additional information about this subject.

Multiple Articles

In the aforementioned situations, the problems are greatly exacerbated if more than a singular small article is dropped, as can occur when a group of such items is accidentally spilled from their container; or worse yet, when the entire container housing them is dropped, in which case a large number of tiny articles may end up widely scattered all over the floor and other surfaces.

Such a spill creates an additional element of urgency and thus an even greater need to find and retrieve each one of these items immediately, for these reasons:

> Unless and until they are completely recovered, the scattered articles are posing the danger of tripping and falling to all attendant personnel or to visitors arriving upon the scene after such an occurrence, with the consequent potential for personal injury, property damage, or both.
>
> There is also the potential for causing damage to the spilled articles themselves, due to the greater likelihood they will be stepped on by nearby personnel or by visitors arriving upon the scene after such an occurrence, with the consequent potential of irreparable damage to at least some of the

articles, causing financial loss, missed deadlines and other adverse effects.

Therefore, it is a further object of this invention to provide the aforementioned retrieving device having a retention capacity sufficiently proportioned, and so configured as to facilitate the capturing, secure holding, and subsequent ejection of one or a multiplicity of small articles, without substantially limiting or constraining the direction or orientation of the device during the process.

Problems Stemming From Difficult Access

There are also instances when a dropped article is in fact clearly observed coming to rest in a certain area, yet that location is so restricted that it cannot be reached by hand, or even with normal gripping devices such as long nose pliers, tweezers, tongs or the like, so that the only practical method of retrieval is the use of suction force. Examples of this are small parts accidentally dropped into one of the many crevices of an automobile engine or other auto body areas during car repair, or into an electronic device filled with wires and other obstructing components, in short, into any narrow, hollow space normally so inaccessible as to require removal or even destruction of the surroundings to gain sufficient access. In such instances the problem is therefore not how to find the article, but how to get close enough to grip it for positive recovery, unless one uses the vacuum suction method.

Therefore, it is a still further object of this invention to provide the vacuum retrieval device previously described, in combination with long enough and thin enough rigid inlet tubes and where needed, flexible inlet tubes, capable of extending into locations otherwise too distant and/or too inaccessible to reach.

Personal Safety Problems

Still another problem that often occurs involves the exposure to injury, namely when the fallen and scattered articles consist of sharp objects capable of causing skin cuts or punctures. Examples are broken pieces of glass, sharp pins, tacks, needles, unbent staples, and similarly dangerous small items. While their recovery is of no material

value, their immediate removal from the affected area is necessary to avoid injury, especially in such places as gyms, pool decks, children's play rooms and any place frequented barefoot. And rather than to merely rely on a visual inspection of the area when purging it of such dangerous elements, it is of considerable benefit to be able to actually collect, view and even count the sharp objects immediately following their retrieval, in order to provide certainty and reassurance to all concerned.

A further advantage of collecting sharp objects by vacuum force instead of by hand is the avoidance of injury during pickup. And by capturing these foreign objects within the hard-surfaced portion of the inlet tubing, before they reach the softer, more vulnerable insides of flexible hoses, internal damage to all downstream components, including hoses, cloth or paper filters, and even the blower unit itself, is also circumvented.

Therefore, it is a still further object of this invention to provide a retrieval device for safely picking up sharp objects capable of causing personal injury and/or damage to the vacuum system, collecting them for viewing and optional counting in a see-through jar, and ejecting them safely from that jar without the need for direct contact by human hands.

Controlling Unwanted Debris

Inasmuch as this device is intended to search for articles of such a wide size range, i.e. from something barely visible to something bigger than the size of a coin, while operating in a variety of environments, i.e. from a substantially clean hard floor to uneven surfaces strewn with all kinds of dust, dirt and debris, it is to be expected that many unwanted items as large as, and larger than the sought-after article will be picked up during the search process as well. As was explained in the foregoing paragraph "Dealing With Debris", under Function C., the orifice size of the filter element determines which articles are allowed to pass through and which ones are stopped. Thus, if the search area contains much debris, such as granules, fibers, lint, hair etc., this will all accumulate within the see-through chamber, and if allowed to build up, will

eventually clog the filter element to the point of reducing and even stopping the airflow. If the lost article has not been found by the time this occurs, it becomes necessary to purge the accumulated debris from the chamber before the search can continue. Depending on the degree of contamination of the search area, it may take several minutes to clog the filter elements, and in severe cases merely a few seconds. In either case, the necessity of periodically halting the search in order to clean the filter represents one of the major time consuming interruptions plaguing prior attempts to handle such vacuum searches. The clogging problem is exacerbated when some particles actually become lodged in the filter orifices, or when lint, fiber, hair and the like tend to partially penetrate the holes, then cling to the surface, which leads to a rapid build-up of debris on the entering side of the filter, making its removal by conventional methods problematic.

Accordingly, it is an important object of this invention to provide the vacuum operated retrieval device having a filter element and a collecting chamber, which are disposed so as to permit "self cleaning", whereby at the option of the user, unwanted debris having collected in the chamber may be passed through to the vacuum system's debris reservoir entirely without the need to open or disassemble the device, and without the need for any direct handling whatsoever. And, in addition to evacuating the chamber, it is a still further object of this invention to provide an easy-to-use mechanism for purging the filter element of any clogged up matter, by directing the airflow in the reverse direction, so as to "back-blast" and thereby positively dislodge any jammed particles.

These self-cleaning functions are quickly and conveniently accomplished by rapid "flick-of-the-wrist" motions on the part of the user, requiring no tools, nor special skills, nor disassembly of any component. Consequently, the speed and effortless ease with which these tasks can be performed render this invention a vast improvement over prior art devices.

Filter Element Orifice Size

The foregoing description showed that the actual filter orifice size determines on the one hand the size of the smallest article the device will capture, and on the other hand, the size of all unwanted particles it will allow to pass through. For example, if the orifices are 1 mm in diameter, any article of or in excess of 1 mm cross section would be caught, while anything smaller than 1 mm is passed through. In such a case, dust, fine granules and perhaps even fine lint and fibers can pass right through, leaving the chamber clear and unobstructed for long periods, yet any lost article 1 mm or bigger is positively captured, whereupon it will be clearly visible somewhere inside the chamber. It follows that larger orifices will capture correspondingly larger articles, while also passing larger contaminants, thus accumulating less debris. Conversely, the smaller the filter orifice size, the smaller will be the article it is capable of capturing, but at the same time, unfortunately, the greater also the likelihood of accumulating unwanted debris very quickly.

This permits a multitude of configurations of my device, each providing its own distinct relationship of capture size vs. debris tolerance, for optimum results under differing search requirements:

Fine Filtering:

A device having its filter orifices sized to intercept articles equal to or greater than, say for instance, 1/10 mm. Such a device would offer the greatest assurance for capturing almost any article imaginable, by covering the widest possible size range. But it would also become choked with debris the quickest, even in relatively clean environments. It would require the greatest number of periodic cleaning operations, at the shortest intervals, a solution made possible and easily accomplished through the unique multi-position self-cleaning means inherent in my invention.

Medium Filtering:

A device with, for instance, 1.5 mm orifices would not be called upon to capture any article quite as tiny as the former, but if properly identified, would still be highly useful for capturing a wide range of articles of that size or bigger, while allowing almost all dust and debris found in average, well maintained places of human occupation to pass through unhindered. This type would require periodic cleaning only in highly contaminated areas, or more infrequently in others.

Coarse Filtering:

A device with orifices greater than, for instance, 2 or 3 mm. Depending on the actual chosen size, such devices can be designated for specific target groups or classifications of items to be picked up, such as automotive fasteners or electronic components, as well as for sifting specific granular or fibrous substances, such as sand, pebbles, sawdust, flaky matter, grass clippings etc.

Fine, or Medium, or Coarse Filtering:

A device having the filter element removably mounted, so as to permit exchanging any element with another of desirable orifice size, thus rendering the searching device capable of handling any one of the foregoing contingencies whenever called upon to do so by the prevailing conditions. This makes my invention the most versatile of all solutions, because an endless variety of filter elements can be provided.

Fine, and Medium, and Coarse Filtering, or
Fine and Coarse Filtering

A device having a filter element with more than one orifice size directly "built-in", and disposed so as to selectively permit the deployment of either size, at the users option, as deemed necessary by the search requirements and by the environment at hand. This combination is the most useful and efficient one, enabling the user to choose the most advantageous filtering mode with quick and

convenient "flick-of-the-wrist" motion, made to "click" into any of the available positions with built-in precision. .

Accordingly, it is another object of this invention to provide a vacuum operated retrieval device, including either an integrally configured or an interchangeably installed filter element incorporating varying orifice sizes, which are predetermined to be most suitable for a given minimum size of articles to be retrieved, or for a known maximum particle size of unwanted matter preferred to pass freely through the system.

Alternately, it is an object of this invention to provide a retrieval device with a simple-to-use selection mechanism, augmented by intuitive detent action, which enables the user to instantly switch, either prior to or during the vacuum searching process, from one built-in filter orifice size to another, whether for the purpose of reducing debris build-up, or for providing greater assurance of capturing the smallest possible lost article. When switching from one filter position to the other, it is important to realize that in the present invention one filter cancels out the effect of the other (e.g. A or B or C), unlike tandem arrangements of the prior art working in series (A plus B). Thus the net effect is the same as that provided by two or three independent filters.

Inasmuch as all of the above described configurations can be derived from the latter combination, it therefore constitutes the preferred embodiment of the invention, and its many advantages, and features, together with the above and other objects, will become more apparent from the following description, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view showing the present invention used in combination with typical vacuum cleaning systems.

FIG.2 is an enlarged isometric view showing the invention used with various types of suction nozzles.

FIG. 3 is an isometric view showing a multiplicity of complements of this invention installed on a vacuum manifold.

FIG. 4 is an isometric exploded view of the invention.

FIG. 5 is a front view, with some of the components partially cut away for clarity.

FIG. 5A is a sectional view taken along the line **5A-5A** of FIG. ***5***, looking in the direction of the arrows.

FIG. 5B is an enlarged cross section taken along line ***5B-5B*** of FIG. ***5A***, looking downward.

FIG. 5C is an enlarged cross section taken along line ***5C-5C*** of FIG. ***5A***, looking downward.

FIG. 6A is a sectional view similar to FIG. ***5A***, with some of its components alternately disposed.

FIG. 6B is sectional view similar to FIG ***5A*** and ***6A***, with another alternate disposition of its components.

FIG. 6C is an enlarged sectional view similar to FIG. ***5B***, with an alternate disposition of its components.

FIG. 6D is an enlarged cross section taken along line ***6D-6D*** in FIG. ***6A***.
FIG. 6E is an enlarged cross section taken along line ***6E-6E*** in FIG. ***6B***.

FIG. *7* is a sectional view similar to FIG. ***5A***, ***6A*** and ***6B***, with yet another alternate disposition of its components.

FIG. *7A* is a fragmentary sectional view similar to FIG. *7*, showing an alternate disposition of one of the components.

FIG. 7B is an enlarged cross section similar to FIG.***5B*** and ***6C***, with another alternate disposition of its components.

FIG. *7C* is a sectional view taken along line ***7C-7C*** in FIG. *7*;

FIG. 7D is a sectional view taken along line ***7D-7D*** in FIG. *7A*;

FIG. 8 is a front view, showing a major component being disassembled.

FIG.8A is a cross section showing 3 alternate positions, taken along line ***8A-8A*** in FIG. ***8***;

FIG. 9A is a fragmentary sectional view showing another embodiment of the discharge area, in the "closed" position.

FIG. 9B is similar to FIG. ***9A***, except shown in the "open" position.

FIG. 9C is a cross section taken along line ***9C-9C*** in FIG. ***9A***.

REFERENCE NUMERALS IN DRAWINGS

10 entire device, assembled
11 upper tube end (exit)
12 tubular extension fitting (hose)
14 vacuum hose, portable
15 lower tube end (intake)
16 extension tube
18 floor nozzle
20 crevice tool
22 tapered extension wand
22a flexible extension (small hose)
24a short extension
24 brush
26a central vacuum system
26b canister type vacuum cleaner
26c upright vacuum cleaner
28 vacuum manifold
28a connector, manifold
29 vacuum source
30 vacuum hose, car wash
32 tube (main member)
34 hub
36 filter element
36a filter element, alternate
38 jar
38a jar, alternate
40 discharge plate
40a seal ring
42 captured articles
44 air exit aperture
46 first re-entry aperture
48a second re-entry aperture
48b second re-entry aperture
48c second re-entry aperture
48d second re-entry aperture
50 plug
52 screw
54 curved surface
58 flange
60 pin
62 slot, twist lock
64 integral bottom
64a integral bottom, alternate
66 hub portion
66a hub portion, alternate
68 orifice
68a orifice, alternate
70 opening
72 retaining ring
74 groove
76 lip
78 coarse filter hole pattern
80 medium filter hole pattern
82 fine filter hole pattern
84 full open filter aperture
86 annular opening
88 bent tab
90 hole
92 lever
94 pin
96 compression spring
98 extended tab
100 pocket, on hub
102 pocket, on lever
104 protruding part of lever
106 beveled protrusion
108 groove
110 inside edge
112 area of contact
114 bevel shaped depressions
116 vicinity of numerals
118 window
120 point to depress lever
122 stop ring
124 groove
126 wide undercut
128 narrow air slots
130 collar, air volume control
132 flow path arrow: coarse
134 flow path arrow: medium
136 flow path arrow: fine
138 flow path arrow, reverse

Description Of The Preferred Embodiment

Referring now to the drawings, FIGs. ***1*** and **2** show a capturing device **10** according to this invention, connected at its upper end **11** to a tubular extension fitting **12** of a flexible vacuum hose **14**, and at its lower end **15** to one of a variety of vacuum intake tools, here partially represented by an extension tube **16**, a floor nozzle **18**, a crevice tool **20**, a tapered extension wand **22** with a flexible extension **22a**, a short extension **24a** and a brush **24**. The connections consist of inserting the slightly tapered male end of one component into the equally tapered female receptacle of the other, causing a snug friction fit for secure and leak proof positioning. Such tapered ends of substantially uniform diameter are common with most makes of vacuum cleaners and associated attachments available in the marketplace, thus making this invention compatible with all of them. Of course, where other dimensional standards prevail, such as metric vs. non-metric, corresponding modifications are easily made.

By way of example, FIG. ***1*** shows the device **10** connected to, among others, a central vacuum system **26a**, a portable canister type **26b**, or an upright type **26c**. There is no limit whatsoever on the type of vacuum system that can be utilized. Even wet applications present no problem other than the possible need for subsequent cleaning of the device. Variations in suction force or air volume do not adversely effect the efficiency and operation of the device, however an optional regulating control (described later) can be provided to enhance usage in certain environments, or when retrieving more delicate, easily damaged items.

FIG. **3** shows how the invention is utilized with a type of vacuum system typically employed in commercial car wash establishments. A vacuum manifold **28** is in communication with a continuous vacuum source **29** and includes a number of integral connectors **28a**, usually one or two per car bay. The upper receptacle **11** of device **10** is attached to the connector **28a**, and a hose **30** connects to the lower end **15**. For this application it is preferred to use more permanent connections in lieu of the tapered friction fit, such as threaded or snap-in types (not shown). And should the manifold

connectors be horizontally oriented, instead of vertically as shown, a 90 degree elbow fitting is added to complete the connection (not shown).

As shown in FIG. **5**, the capturing device of this invention includes a tube **32**, a hub **34**, a filter element **36**, a jar **38**, a discharge plate **40**, as well as fasteners and positioning components further described below. In addition to comprising the air inlet at its lower extremity **15**, and the air outlet at its upper extremity **11**, the tube **32** serves as the main structural member to which all other elements are mounted. At this point it is noted that the terms "upper" and "lower" are meant to relate to the orientation of the entire device as shown on the drawings, which for the most part is indeed the preferred orientation during vacuum operation, and particularly during the discharging of the captured articles **42**, after the vacuum stream has been switched off. However, it is one of the advantages of this invention that during a vacuum search the device may be held in any desirable orientation, as necessitated by the search, whether vertical, horizontal, right side up or upside down.

Located near its medial region, the tube **32** incorporates an air exit aperture **44**, a first re-entry aperture **46**, and a group of second reentry apertures **48a**, **48b**, **48c**, and **48d**. Disposed fixedly inside of the tube **32** between the aperture **44** and the apertures **48a,b,c,d** is a stationary plug **50** secured with a screw **52**, incorporating a curved surface **54** that is facing aperture **44**. Alternately, the plug **50** may be formed as an integral, contiguous part of tube **32**, as may be contemplated if the tube is produced by injection molding. By obstructing the continual straight air path through the internal cylindrical passage formed by tube **32**, plug **50** thus diverts the vacuum induced supply air stream, flowing from the inlet end **15** of tube **32,** to a region encompassed by the jar **38**, which surrounds the tube from a point substantially below aperture **44** to just above the upper edge of aperture **46**. Thereupon the supply air re-enters tube **32** either through aperture **46**, or through apertures **48a,b,c,d**, depending on which one presents the largest open area. That in turn depends on the position of the filter element **36**, which covers all the re-entry apertures **46** and **48** at all times.

The jar **38** is comprised of a see-through transparent plastic material in order to facilitate visual detection of all captured articles, and is engaged at its upper extremity with a flange **58** of the hub **34**. It is held in place by a pin **60**, which engages the jar near its rim via a twist lock slot **62**, commonly known as a rifle lock. At its lower extremity, jar **38** defines an integral bottom **64** and a hub portion **66,** whose inside diameter is just slightly larger than the diameter of tube **32** over which it fits, thus forming an effective seal between the atmosphere and the interior of jar **38,** yet permitting free rotational and sliding movement of the jar with respect to tube **32**. The bottom **64** incorporates an orifice **68**, intended for discharging any captured articles **42** which accumulate inside the jar.

The discharge plate **40** fits rotatably over the outer diameter of the hub portion **66**, and is secured by a retaining ring **72**, which snaps into a groove **74.** Plate **40** incorporates an opening **70**, which aligns with the orifice **68** of jar **38** whenever it is rotated to the position shown in FIGs. ***7A*** and ***7D***. This allows any captured article or articles **42** to be discharged without the necessity of removing the jar itself.

During normal vacuum operation, the discharge plate **40** is rotated so that the orifice **68** remains effectively covered and sealed against the atmosphere, as shown in FIG. ***7C***. Detent means (not shown) may be provided to aid in positioning the plate precisely.

In an alternate embodiment of this invention, the components provided for discharging captured articles are configured as shown in FIGs. ***9A***, ***9B***, and ***9C***:

The lower extremity of a jar **38a**, otherwise identical to jar **38**, defines a bottom **64a**, which is inwardly inclined at an angle steep enough to cause captured articles to fall to its lowest level, when the device is held in an approximately vertical position after the vacuum flow has been turned off. The bottom **64a** incorporates a plurality of orifices **68a** equally spaced apart. The jar **38a** also incorporates an extended hub portion **66a**, whose inside diameter fits freely over tube **32**. A V-shaped, dish like seal ring **40a** fits snugly over the outside diameter of the hub portion **66a**, held in position by moderate friction.

An integral lip **76** provides a bottom stop and prevents the seal ring **40a** from slipping off. The angle of the seal ring **40a** matches that of jar **38a.** With the seal ring in its upper position (FIG. ***9A***), its orifices **68a** are effectively sealed from the atmosphere. When captured articles are detected within jar **38a**, vacuum is turned off, and seal ring **40a** is slid to its lower position (FIG. ***9B***), allowing the captured articles **42** to fall into the dished rim for retrieval.

The filter element **36** defines a cylindrical shape, is comprised of sheet metal, and incorporates a series of three different hole patterns, each of which has a total free area equal to or greater than the area of the inside diameter of tube **32.** The hole patterns are sized to provide a "coarse-medium-fine" range of filtering capabilities, indicated by **78**, **80**, and **82** - or alternately, a "full open-medium-fine" capability provided by a filter element **36a**, shown in FIG. ***4*** and denoted as **84**, **80**, and **82.** The filter element is held fixedly within a concentric annular opening **86** of the hub **34**, with a bent tab **88** protruding into a hole **90**, thus holding it in angular and axial register with hub **34.** Consequently, any motion and position change imparted upon the hub is duplicated by filter element **36.** This assures that its various hole patterns always align as intended with the air path apertures of tube **32.**

A lever **92** is mounted pivotably in the upper slot-like space of hub **34**, retained by and pivoting about a pin **94.** A compression spring **96** is disposed between the upper portion of hub **34** and an extended tab **98** of the lever **92**, retained by a pocket **100** and a pocket **102**, as shown in FIG. ***5B.*** The spring **96** constantly presses the protruding part **104** of the lever **92** away from the center, thereby urging its opposite end, which incorporates a beveled protrusion **106**, toward the center of tube **32.**

The hub **34**, together with the filter element **36** or **36a**, is slideably and rotatably fit over tube **32**, as shown in FIG. ***5A.*** In its normal longitudinal position, the lever **92** aligns with a groove **108** of tube **32**, and an inside edge **110** of lever **92** engages with the groove **108** at a contact area denoted by **112**, due to being urged towards it by the force of spring **96.** This assures that hub **34** is restrained against any longitudinal movement with

respect to tube **32**, i.e. any movement parallel to their common axis. The center bore of hub **34** and the inside surface of the cylindrical filter element **36** are of the same diameter, which is just slightly larger than the outside diameter of tube **32**, thus forming an effective seal between the various air passages **44**, **46** and **48** of the tube, while at the same time allowing the hub and the filter element to be freely rotated in either direction. The groove **108** incorporates three bevel shaped depressions **114** similar in profile to the beveled protrusion **106**, which are equally spaced around the groove's perimeter, and extend across its width. As hub **34** is rotated, protrusion **106** will engage with the first of the depressions it encounters, resulting in a positive detent stop. Rotating hub **34** in either direction, using only moderately increased force, will automatically disengage protrusion **106**, in order to advance to another position (See FIG. ***6C***). In this manner, three discrete angular detent positions are attainable when rotating hub **34** about tube **32**, while at the same time maintaining its longitudinal position, as indicated in FIG. ***5B***. Each of the 3 positions will provide the operator with a different filtering capability:

Position 1:

If equipped with the filter element **36**, the device will capture any article larger than the hole diameter of a "coarse" hole pattern **78**, while allowing almost all normal debris, lint etc. encountered in the process to pass on through. If equipped with an alternate filter element **36a**, this position is full open, permitting everything to pass through unhindered. See FIG. ***4***, showing the filter element **36a**, which incorporates an aperture **84** equal in size to aperture **44** of tube **32**. Therefore, while providing a needed convenience, position 1 is to be used with the greatest caution.

Position 2:

Will capture any article larger than the hole diameter of a "medium" hole pattern **80**, while still allowing fine dust, smaller granules and pieces of debris to pass through. Some lint, hair and other debris may slowly accumulate during extended search periods.

Position 3:

Will capture any article as tiny as the hole diameter of a "fine" hole pattern **82**, while still allowing fine dust and finer granules to pass on through. Larger debris will also accumulate, congregating more rapidly than in position 2. Position 3 requires more frequent checks for results, each followed by a quick "self cleaning" procedure.

To enable the operator to easily distinguish between the foregoing filter positions, the numerals 1,2,3 are inscribed bright and highly visible on the exterior of tube **32** in a vicinity **116** covered by hub **34**. A window **118** in hub **34** is placed so as to align itself with the appropriate numeral whenever any one of the three detent positions is in engagement.

Referring to Fig. ***7B***, when the lever **92** is depressed near a point **120**, its opposite end moves away from detent depression **114**, and if fully depressed, the edge **110** and the protrusion **106** will completely clear groove **108** so as to release hub **34** from its longitudinal restraint with tube **30**. Thus hub **34** with its integral filter element **36** can slide downward until the lower extremity of the filter element makes contact with a stop ring **122**, which is fixed in position on tube **32** in a groove **124**. See FIG. *7*. When in this position, hub **34** may be freely rotated through 360 degrees in either direction. As will be explained under "Operation", this filter position is used for self-cleaning of the capturing device.

Referring to FIG. ***8***, the upper portion of tube **32** incorporates a wide undercut **126**, whose diameter is just slightly less than the tube outside diameter. A series of narrow, adjacent slots **128** pierce the tube wall within the confines of the undercut. A collar **130**, substantially cylindrical in shape, but with part of its circumference removed, and having an inside diameter slightly smaller than the diameter of the undercut **126**, fits snugly over it, held by friction in any desired angular position. With only slight force it can be rotated to any other position, so as to cover the slots **128** completely, partially or not at all, as illustrated in FIG. ***8A***. This comprises a "vacuum volume control", to be elaborated upon subsequently.

OPERATION

With the device connected to a vacuum source, and a suitable nozzle at its intake:

Position 1:

Assuming that a number of small fasteners, such as screws, nuts and washers are to be found and captured, any of which are known to be larger than the holes in the "coarse" pattern **78** of filter element **36**, the operator rotates hub **34** until it clicks in position with the numeral "1" in window **118.** This aligns the internal air passages as shown in FIG. ***5A***, and upon activating the vacuum source, air is immediately drawn from intake **15** through aperture **44** into jar **38**, then through filter holes **78** and aperture **46** (See FIG. ***5C***) out through exit **11**, as indicated by a flow path arrow **132.** As a result, any article entrained in the air stream will be intercepted by filter element **36** if it is larger than holes **78**, and pass through if it is smaller. Upon visual discovery, it is then discharged through orifice **68** as previously described.

Position 2:

If the lost article is smaller than hole pattern **78**, the operator selects hub position 2 in window **118.** The internal air passages are now aligned as shown in FIG. ***6A***, so that aperture **46** is now blocked by the solid portion of filter element **36**, and the "medium" hole pattern **80** is aligned with apertures **48a** and **48b**, shown in FIG. ***6D***. This now constitutes the air path of least resistance, depicted by a flow path arrow **134.** Anything larger than holes **80** will be captured within jar **38.**

Position 3:

If the lost article is smaller still than the holes **80**, or if its size is unknown, the safest selection to be made is hub position 3. This aligns the internal air passages as shown in FIGs. ***6B*** and ***6E***, whereby aperture **46** is still blocked by the solid portion of filter element **36**, and filter holes **80** are blocked by the solid portion of tube **32**, so that the path of least resistance is now through the "fine" hole pattern **82**, as depicted in FIG. ***6B*** by a flow path arrow **136.**

Self-Cleaning:

As was pointed out previously, it is inevitable that a certain amount of debris, lint, and other foreign matter is picked up during a search, especially in position 3, and to a lesser degree in position 2. This debris will collect for the most part on the surface of filter element **36**, where it is easily examined all around the perimeter in order to check for the lost article. If the latter is not present, the debris may be purged from jar **38** within seconds, by simply rotating hub **34** to position 1. This immediately opens up the larger passages through hole pattern **78**, and the resulting blast is usually sufficient to suck everything out of the area toward the vacuum source. During this process, discharge plate **40** can also be rotated so that its orifice **68** is at least partially open, which has the effect of purging any foreign matter from the lowermost zones of jar **38**.

Under conditions where severe concentrations of debris are encountered, it is possible for some lint or fibers to cling more tenaciously to filter element **36**, so that the above procedure cannot entirely remove them. This is easily remedied by depressing the lever **92** and lowering jar **38** to the position depicted in FIG. *7*, whereby aperture **44** is now facing the interior surface of filter element **36**, and the "coarse" hole pattern **78** is aligned with apertures **48a,b,c** and **d**. This directs the air blast through the filter holes **82** and **80** in the reverse direction, as depicted in FIG. *7* by a flow path arrow **138**. During this process, hub **34** can be freely rotated as well as incrementally moved in the longitudinal direction, so as to expose every portion of the filter's interior to the air stream in a form of "sweeping" action, until all foreign matter has been purged.

As a last resort, should the debris build-up inadvertently reach extreme conditions of crowding or compacting, the entire jar **38** is easily removed from hub **34** as depicted in FIG. ***8***. First, the vacuum is turned off, the intake nozzle is removed from tube end **15**, then the jar is freed from pin **60** with a twisting motion, and slid off of tube **32**.

Vacuum Volume Control:

In normal use, the collar **130** is disposed so as to fully cover the slots **128**, which permits the maximum airflow delivery through the system, as depicted in FIG. ***8A***, left most detail. Where it is desired to diminish the air volume and velocity at the nozzle entry of the system, be it to avoid sucking in adjacent items which may tend to clog the entrance, or to use a more gentle air stream for picking up delicate articles, collar **130** is rotated as needed to allow more air to enter the system at that point. This will cause a corresponding airflow reduction at the nozzle entry.